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Executive Summary

The Role of this TMDL and the Overall Water Quality Improvement Process

The overall process for improving water quality as laid out in the Clean Water Act involves several steps. First, the desired water quality is defined via state water quality standards. Second, waters of a lower quality than the water quality standards are identified on state 303(d) lists (also known as "Lists of Impaired Waterbodies"). Third, a Total Maximum Daily Load (TMDL) is established for waters on the 303(d) list. Fourth, implementation plans are developed by the state to achieve the TMDL. Fifth, in some cases, a balance must be struck between the TMDL and the water quality standards. During implementation planning, it may become clear that there are no feasible improvement alternatives that will achieve the TMDL. In these cases, the TMDL and the water quality standards may have to be adjusted to achieve the highest levels of water quality that are feasible. Finally, the TMDL is implemented through the NPDES Permit Program, State Water Quality Standards Certification Program, the States Non-point Source Management Program and other appropriate mechanisms.

Often the TMDL and the implementation plan are developed together and there may even be iterative manipulation of the two until a workable mix is achieved. In the case of the main stems temperature TMDL, the two have been kept some what separated. Interest in temperature in the main stems peaked during development of the 2000 Federal Columbia River Power System (FCRPS) Biological Opinion by the National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service (FWS). Many believed that elevated temperatures played a role in the reduction of salmon runs, while others believed that temperature in the main stems had not changed significantly from natural conditions. Further, the water quality standards do not establish a clear target for temperature and require considerable analysis. So it wasn't clear if there was a temperature problem, how severe it was or what was causing it. Implementation planning to improve water temperature could be very costly, especially for the federal and public utility district dams on the rivers. Therefore, it is prudent to verify that a problem exists and to quantify the extent of the problem before investing a great deal. Essentially, the role of this TMDL in improving temperature in the Columbia/Snake River main stems is to clarify these issues. The purpose of this TMDL is to:

1. define the temperature targets;
2. quantify the temperature problem on the main stems;
3. determine the level of improvement needed.

The TMDL, therefore, uses water quality modeling to determine the specific water temperature targets for the main stems on the basis of state water quality standards. The water quality standards require identification of what the temperatures would be in the absence of human activities on the main stems. Having determined the temperature regime required by the state water quality standards, the TMDL evaluates whether the existing main stems achieve those target temperature regimes and quantifies the contributions of existing human activities to temperature increases in the river. This TMDL finds that temperature does exceed the target temperature regimes required by state water quality standards so it goes on to quantify the improvement needed and allocate heat loads to the various human activities on the main stems that, if achieved, will result in compliance with the target temperatures.

The next step in improving temperature in the main stems is to develop the implementation plan. That is, determine what specific operational changes at the dams and point sources of heat along the rivers can be implemented to achieve the TMDL and ultimately achieve water quality standards. In other words, what feasible alternatives are available to improve temperature. The TMDL identifies some of the dams on the main stems to be the major contributors to temperature increases in the main stems. Implementation planning to achieve temperature improvements at dams will be technically complicated, costly and generally outside Clean Water Act authorities. The federal dams were specifically authorized by Congress for specific purposes such as flood control, power generation, irrigation and navigation. Decisions on the feasibility of alternatives to improve temperature at these facilities will have to consider the ability of the FCRPS to continue achieving the purposes established by Congress, the technical feasibility of the alternatives and the economic feasibility of the alternatives.

The states take the lead for TMDL implementation planning but they will rely heavily on the Federal Agencies that administer and operate the FCRPS. In fact, development of improvement alternatives will require a sytstem wide evaluation of the FCRPS and the Columbia/Snake River system. Improvements in temperature resulting from operation of the river system will rely heavily on regional, national and even international forums. Because of the complicated policy and technical issues incumbent on implementation planning, in this case, it could be a lengthy process.

However, that is not to say that the FCRPS has been inactive in planning and implementing measures to improve water temperature in the Columbia and Snake River main stems. The Bonneville Power Administration is financing sub-basin planning all over the Columbia Basin to improve salmon habitat, including temperature in the tributaries to the Columbia and Snake Rivers. The Corps of Engineers has operated Dworshak Dam for the last three years to discharge cooler water to improve temperature in the lower Snake River. Every year, the Corps works with EPA, NMFS and the states and tribes to refine and fine tune it's approach to operating the Dworshak Dam. Two major limitations on implementation planning have been the lack of data to adequately characterize water temperature and the lack of water quality modeling that can evaluate the effects of improvement alternatives at specific dams and site along the river. In 2002, the FCRPS agencies began an effort to address these limitations. Working with NMFS, FWS, EPA, the states and the tribes, the FCRPS agencies developed an interagency committee that is evaluating monitoring and modeling efforts on the rivers. That committee, chaired by the Corps and NMFS, will determine appropriate water quality models and the monitoring necessary to support those models. That committee has been very active and has resulted in intensive monitoring efforts in 2002, including monitoring of temperature in fish passage facilities. The Bureau of Reclamation has been active in working with EPA in development of the TMDL to ensure that there is an adequate understanding of the operation of Grand Coulee Dam and the Columbia Basin Irrigation Project and to brain storm improvement measures that can be evaluated to determine if they are feasible and will have a beneficial effect on water temperature downstream of Grand Coulee while not causing impairment of temperature upstream of the dam in Lake Roosevelt.

Continued cooperation of the federal agencies, the states and tribes will ensure that the implementation planning results in a balanced strategy that considers ecological needs above and below Grand Coulee, achievement of the Congressionally authorized purpose of the FCRPS and is technically feasible and economically achievable. Step 5 of the water quality improvement process is to alter the TMDL and the water quality standards, as appropriate, to strike this balance between competing ecological needs and competing uses and values of the river system. If it is not feasible to achieve the TMDL without sacrificing ecological needs upstream of Grand Coulee or the other uses of the river system, the water quality standards can be amended and the TMDL revised to achieve the new standards.

The EPA water quality standards regulations provide for situations where water quality standards cannot be attained. The regulations specifically address dams. At 40 CFR 131.10(g) the regulations say "States may remove a designated use which is not an existing use, as defined in Sec. 131.3, or establish sub-categories of a use if the state can demonstrate that attaining the designated use is not feasible because: ....(4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use." The regulations also address te concept of economic feasibility at 40 CFR 131.10(g)(6): "Controls more stringent than those required by sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact."

Sequentially, the final step in the improvement process is actual implementation of the measures to improve water quality. In actuality, implementation can occur simultaneously with the planning processes and in this case a great deal of work is being done to improve temperature in the Columbia and Snakes rivers as described above. The whole water quality improvement process outlined above, including the TMDL will be an iterative process. As the FCRPS agencies continue to work toward temperature improvements, develop water quality models and collect water quality data, the TMDL may updated.

Description of Waterbody, Pollutant of Concern, and Pollutant Sources

This Total Maximum Daily Load (TMDL) addresses water temperature in the mainstem segments of the Columbia River from the Canadian Border (River Mile 745) to the Pacific Ocean and the Snake River from its confluence with the Salmon River (River Mile 188) to its confluence with the Columbia River. The States of Oregon and Washington and the U.S. Environmental Protection Agency (EPA) have listed multiple segments of both mainstem reaches on their federal Clean Water Act (CWA) 303(d) lists due to water temperatures that exceed state water quality standards (WQS). The entire reaches of both rivers are considered impaired for water temperature. EPA is establishing this TMDL for waters within the States of Oregon and Washington and within the Reservations of the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians. At this time, the Idaho Department of Environmental Quality is anticipating simultaneously issuing the TMDL for waters within the jurisdiction of the State of Idaho.

Water temperature can be elevated above natural conditions by a number of human activities. The primary sources of elevated temperatures in the Columbia and Snake Rivers are point sources, nonpoint sources, and dams. Point sources discharge thermal energy directly to the river. Nonpoint sources such as agricultural run off discharge to the rivers primarily via irrigation canals and tributaries. Dams alter river temperature by changing the flow regime, stream geometry, current velocity and flood plain interactions of the river.

The effects of point sources and tributaries (nonpoint sources) on cross sectional average water temperatures in the main stems are for the most part quite small. The point sources can cause temperature plumes in the near-field but they do not result in measurable increases to the cross-sectional average temperature of the main stems. That is, the cumulative impact of all the point sources is less than 0.14 °C when temperature criteria are exceeded in the river. Some of the dams, however, do cause measurable changes in the cross-sectional average temperature of the main stems. They increase the cross-sectional average temperature and they extend the period of time during which the water temperature exceeds numeric temperature criteria. The impact to water temperature of the dams ranges from very small at Priest Rapids where the maximum impact is about 0.09 °C to the impact of Grand Coulee which is as high as 6.0 °C in the late fall. Eight of the 15 dams have maximum impacts to temperature of over 0.5 °C.

Description of the Applicable Water Quality Standards and Numeric Targets

The WQS for temperature on the Columbia and Snake Rivers are quite complex. The three states and one tribe with EPA-approved standards have adopted a variety of numeric and narrative criteria for temperature in the segments of the Columbia/Snake mainstems within their jurisdictions. A common component in all of the standards is a provision to account for times when natural water temperatures in the rivers exceed numeric water quality criteria. Generally, when this occurs, the standards allow small incremental increases to the natural temperatures. Washington WQS, which apply to all of the TMDL project area except the upper 12 miles of the Snake River reach, also restrict incremental increases in temperature when the natural temperature is below numeric criteria. The TMDL is based on the most stringent standards that apply on the rivers reach by reach. Table S-1 summarizes the WQS standards that are the basis for this TMDL.

Table S-1: Summary of Water Quality Standards that Apply to the Columbia and Snake Rivers

Columbia River Reach	Criterion	Natural Temp < Criterion	Natural Temp > Criterion
Canadian Border to Grand Coulee Dam	16 °C DM	Natural + 23/(T+5)	Natural + 0.3 °C
Grand Coulee Dam to Chief Joseph Dam	16 °C DM	Natural + 23/(T+5)	Natural + 0.3 °C
Chief Joseph Dam to Priest Rapids Dam	18 °C DM	Natural + 28/(T+7)	Natural + 0.3 °C
Priest Rapids Dam to Oregon Border	20 °C DM	Natural + 34/(T+9)	Natural + 0.3 °C
Oregon Border to mouth	12.8/20 °C DM	Natural + 1.1 °C	Natural + 0.14°C
Snake River Reach	**Criterion**	**Natural Temp < Criterion**	**Natural Temp > Criterion**
Salmon River to OR/WA Border	12.8/17.8 °C 7DADM	Up to Criterion	Natural + 0.14 °C
OR/WA Border to ID/WA Border	20 °C DM	Natural + 1.1 °C	Natural + 0.3 °C
ID/WA Border to Mouth	20 °C DM	Natural + 34/(T+9)	Natural + 0.3 °C

T = the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.
DM = daily maximum temperature.
7DADM = seven day average of the daily maximum temperatures..

Development of the target temperatures for the TMDL depends on an understanding of natural temperature. A mathematical water quality model was used to simulate temperature conditions in the mainstems of the Columbia and Snake Rivers in the absence of human activity in the mainstems. The simulations utilize existing flow and temperature in the tributaries and at the TMDL boundaries. These simulated temperatures are an approximation of natural conditions because they do not account for possible impacts from altered water temperature and flow regimes outside the TMDL project area. To maintain the distinction from purely natural temperatures, these simulated temperatures are referred to as site potential temperatures. This TMDL is based on the site potential temperatures; the temperatures that are estimated to occur in the absence of human activity in the mainstems.

The site potential temperatures in the mainstems vary considerably throughout the year, from year to year, and longitudinally along the rivers. To account for the temporal variation, the site potential temperatures are simulated using a thirty year data record and the target temperatures for the TMDL are expressed as thirty year mean temperatures for every day of the year. To account for the spatial variation, the rivers are divided into 21 longitudinal reaches with a TMDL Target Site at the down river end of each reach.

The mathematical model has been used to evaluate cumulative impacts of upstream temperature impacts on downstream segments of the TMDL. This analysis indicates that elevating temperatures of upstream segments to the degree allowed under the WQS (Table S-1) would result in exceedances of WQS in downstream segments. As a result, the target temperatures in the lower reach of the Columbia River drive the upstream allocations for this TMDL. Therefore, the target temperatures of each reach above the Oregon/Washington Border are lower than those indicated by Table S-1. The targets at each upper reach are lowered enough to ensure that the target temperature in the downstream reach are achieved. Figure S-1 illustrates the existing temperature and the TMDL target temperature at the John Day target site.

Application of the Target Temperatures

The target temperatures for this TMDL are expressed as daily cross sectional average temperatures. The cross sectional average temperature is representative of the free flowing river because it was generally well mixed. The target temperature must be achieved as a daily cross sectional average in the impounded river but also throughout the width and depth of the thalweg, in critical fish habitat and in fish ladders and holding facilities.

Loading Capacity

The loading capacity is expressed as temperature rather than as thermal load. The regulations governing TMDL development provide for the expression of TMDLs as "either mass per time, toxicity, or other appropriate measure" (40CFR130.2(h)). Temperature is an appropriate measure in this TMDL because dams play a major role in altering the temperature regime of the river but they do not discharge water bearing a thermal load to the river. Dams alter the temperature regime of the river by altering the stream geometry and current velocity upstream of the dam. Expressing the loading capacity and allocations as temperatures addresses a potential concern that dam operators could choose to alter flow in the river to achieve thermal load targets without improving temperature. In this TMDL, the loading capacity is the daily target temperature at River Mile 4 of the Columbia River as depicted in Figure 5-1 and in Appendix B.

Pollutant Allocations (see Table S-2)

The underlying philosophy used to establish this TMDL was to allocate available heat capacity to the smallest sources first and work up the list until the available capacity is fully allocated. That is, allocate existing heat load to as many sources as possible. This philosophy arises from the fact that there is insufficient capacity to provide the larger sources any meaningful relief since the total capacity to be allocated is only 0.14 °C most of the year. Therefore, the TMDL first allocates sufficient loads to account for existing discharges from individual NPDES permittees and 20 MW at each target site to account for general NPDES permittees. Any future growth will have to be part of the 20 MW allocated to general permits. The TMDL then allocates remaining capacity to account for as many of the dams as possible beginning with the dams with the smallest effect on temperature.

The analysis of NPDES point sources in the watershed indicates that the cumulative loading of temperature to be deminimus in comparison to the effects of the dams and never in and of itself results in exceedance of water quality standards. Even if this TMDL were to allocate the site potential temperature to each point source (ie., a wasteload equal to meeting water quality standards at the end of the discharge pipe), the applicable water quality standards would not be attained in the waterbody because of the temperature increases caused by the dams. In fact, very little benefit would be realized in terms of temperature reductions needed by the dams to achieve water quality standards. At the same time however, EPA recognizes that discharged heat may have local effects even at very small quantities, and as such, should be limited to the extent practicable. Taking these two considerations into account, this TMDL therefore provides a cumulative wasteload allocation applicable to all NPDES facilities in the mainstems that never exceeds 0.14 °C whenever site potential temperature is greater than the water quality criteria. That is, the cumulative effects of all the NPDES point sources is never measurable when the rivers exceed water quality criteria. EPA believes that the wasteload allocations in this TMDL are reasonable in light of the following factors.

1. The NPDES point sources, in the aggregate, contribute less than 0.14 °C to the total temperature within each reach when temperature exceeds water quality criteria;
2. Limiting the point source discharges to site potential temperatures will have no measurable effect on water quality and reducing them beyond the levels contemplated by the cumulative wasteload allocation is not necessary to achieve water quality standards;
3. The majority of the temperature increases (as much as 6 °C) are cause by the larger dams: therefore, water quality standards cannot be achieved under Clean Water Act authorities, but rather need to be accomplished through federal, state, local and even, conceivably, international mechanisms.

The load available for allocation is the temperature increment over the natural or site potential temperature allowed under the WQS. For example, at the furthest downstream point in the river, this increment is 0.14 °C when numeric criteria are exceeded and 1.1 °C the rest of the time. Much of this temperature increment is consumed by the allocations to the point sources as wasteload allocations (WLA). In the WLA, the load each point source can discharge to the river is expressed as megawatts (MW). There are 106 Point Sources with individual NPDES permits in this TMDL. All but 11 of these point sources have only a minimal effect on mainstem temperatures (defined for the purpose of this TMDL as less than 0.014 °C). These 95 smaller point sources are included in group allocations for each reach. The 11 larger point source dischargers receive individual allocations.

EPA, Oregon and Washington have issued 27 general NPDES permits. Currently 16 of them have a total of 96 permittees that discharge to the Columbia or Snake Rivers. The contribution to temperature from the sources covered by the general permits is minimal; especially when compared to the temperature loads from large point sources and the impacts of the dams. An additional 20 megawatts is added to each group allocation to account for these sources.

Since the site potential simulations incorporate existing tributary temperatures, none of the temperature increment is allocated to tributaries. All tributaries are allocated their existing loads.

The temperature increment remaining to be allocated after allocation to the point sources is very small and therefore, the temperature increase allocated to the 15 dams is also very small. Wells, Rocky Reach, Rock Island and Priest Rapids dams have very smal effects on water temperature. They are provided allocations that accounts for the small effects tat they currently have. The other dams receive no allocation.

Margin of Safety

Implicit margins of safety have been built into the TMDL. For point sources the WLA is based on reasonable worst case discharges. Further, the wasteload allocation for point sources does not vary with flow. It achieves water quality standards at the 7Q10 low flow, thereby providing a margin of safety when flows are greater than the 7Q10. For dams, the use of daily average temperatures (as opposed to maximum temperatures only) is a conservative application of the WQS provisions regarding natural temperature conditions.

Seasonal Variation

The water quality standards for temperature, temperature itself and the effects of human activities on temperature all vary seasonally during the year. In the winter and spring, water quality standards are not exceeded, and therefore the waters of the Columbia and Snake rivers are not impaired for temperature from human activities within the main stems. In the late summer and fall, water quality standards are exceeded and the site potential temperatures exceed the water quality criteria, requiring TMDL allocations for temperature that ensure temperature doesn't exceed site potential temperature + 0.14 °C. In the late fall and early winter water quality standards are exceeded but the site potential is less than water quality criteria requiring TMDL allocations that ensure temperatures don't exceed site potential + 1.1 °C. The seasonality of the TMDL is summarized as follows:

February 6 through July 31	- no allocations required;
August 1 through October 31	- allocations to achieve site potential Temperature + 0.14

°C;

November 1 through February 5 - allocations to achieve site potential Temperature + 1.1 °C.

Future Growth

A small portion of the available temperature increases has been allocated to future growth in the group allocations. Twenty MW of heat energy have been added to each group above that needed by the dischargers in the group.

Monitoring Plan

Long term, system wide effectiveness of TMDL implementation activities can be assessed by monitoring mainstem river temperatures at the target sites. Over the long term, if implementation is adequate, the daily mean temperatures at the target site should equal the 30 year mean target temperatures at those sites. Individual years may exceed those temperatures because of natural variation.

Short term monitoring for compliance with WLAs will be accomplished through effluent monitoring by the point sources. For individual dams, one option for short term monitoring is to evaluate the temperature difference between successive dams. The TMDL includes curves showing the temperature differences for existing conditions and for the conditions of the implemented TMDL. Effectiveness of TMDL implementation within individual impoundments can be determined by comparison of actual temperature differences between dams to the TMDL curves.

Implementation Plans

Implementation plans will be developed by the States and Tribes.

Public Participation

Extensive public involvement activities, organized by the inter-agency TMDL Coordination Team have occurred for this TMDL over the past two years. Activities have included websites, fact sheets, coordination meeting, individual meetings with interested groups, nine public workshops and numerous conference presentations. Public participation efforts will continue until the TMDL is finalized. Three public workshops are planned to review the preliminary draft TMDL and public meetings with the opportunity for public comment will be held during the draft TMDL comment period.